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able measure of uniformity and which goes far to establish the rank of such categories as genus, species and variety. This fact is clearly shown by the contrasting work of those free-lances who, armed with the less effective weapons of a more restricted knowledge, have in doing independent battle upon the difficulties of generic classification followed other tactics and set up new standards. I doubt if they have realized how quickly and fully the personal equation is recognized in regard to their work, or how generally even the amateur and layman grasp the fact that their generic and specific propositions are not up to the standard. No one can change the temperature by making the degrees of his thermometer smaller. Least of all is it possible to make people believe that the shortened degree is as important as the longer one. Time spent in this mere letting down of standards and shifting of ranks is worse than wasted. The process is annoying and confusing, for to the natural difficulties of generic classification plus a certain inevitable historic element of artificiality, it superimposes the most awkward and irritating difficulty of all, namely, the personal equation.

Let us get something done and not spend our time in endless and profitless strife about first principles, thereby bringing confusion into what may be regarded as fairly well established already. There are limitless fields for further profitable work in the finer classification of the flowering plants without perpetual tampering with the boundaries of important and long-studied genera—a type of activity very prone to sink to the level of a mere juggling with names. Having said so much against generic changes of a superficial character, I fear some of my hearers may get the impression that I am opposed to generic changes in general and perhaps even to the further investigation of generic limits;

but this is in no wise the case. There is certainly great opportunity for further and very profitable study of generic classification. The genera of several families, as for instance the Cruciferae, are in many cases pretty artificial groups. We need much further knowledge of the relationships of the species concerned. Let those who wish to be of real service in this matter give us what we so much desire, namely, additional light upon the ontogeny, embryology or finer anatomy of these species, sources of information sure to yield data of high classificatory importance.

In closing let me urge that, while we remit no effort to secure further light on this subject, there should be a general agreement to treat the accepted and traditional interpretation of large and important genera as sacred and binding until we can furnish definite and convincing evidence that change is needful, and that for the welfare and dignity of our science, all should unite in opposing changes of the artificial sort, which consist merely in the shifting of ranks and modification of standards.

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*INVESTIGATIONS AND COMMERCIAL TESTS
IN CONNECTION WITH THE WORK OF
AN ENGINEERING COLLEGE.¹*

IN any school it is necessary, in securing the best efficiency in instruction, that the professors shall be able to speak with authority on the subjects which they teach. In technical schools those who teach the practical engineering subjects can not speak with authority unless they have had practical experience. Investigations and commercial tests may serve to give them this practical experience, and the question naturally arises—is it a good policy for pro-

¹ Address of the vice-president and chairman of Section D—Mechanical Science and Engineering, at New Orleans, December 29, 1905.

fessors to conduct such work in connection with their regular college duties?

Let us consider the various ways in which a professor in an engineering school may acquire the practical experience which is necessary in his work.

First, he may be called to a professorship from the practical field.

Second, after teaching for a time and finding how necessary a practical experience is in his work, he may turn to the practical field, and then return to teaching.

Third, he may undertake practical work in connection with his college duties, and gain his experience in this way.

Each method possesses its own advantages and disadvantages. Starting with the first, it must be admitted that many of our best instructors have entered the teaching line after they have had experience in the practical field. Such a man has an advantage in being able to make use of this experience immediately, when he starts in at his teaching work. There is a disadvantage, however, in the fact that should he have secured a mature experience in the practical field, he will necessarily be no longer a young man, and it may be hard for him to teach and to properly adapt himself to the theoretical part of his course. Again, if he has made a marked success in the practical field his financial reward may be so great that he would have to make a considerable sacrifice in this respect should he turn to teaching. There are some men who, from their love of teaching or through the influence of high ideals, have been willing to do this, but these are few, and the college obtaining such a man is, indeed, fortunate. This side of the problem is a serious one from the standpoint of the college, because the man it would like to get may be beyond its reach, and those available may have made only a partial success in the practical field.

If a young man with a limited practical

experience becomes a teacher, this will be of assistance to him, but not as much as the more mature experience of an older man. In either case, a professor should not assume that, having had a practical experience, this is all-sufficient, and that it simply rests with him to base his teaching on the results of this experience. To keep in touch with what is going on it will be necessary for him to spend much of his time in studying what is being done in the outside field, or to resort to the third method, and do practical work in connection with his regular college duties. If he does not do this he will soon fall behind-hand, and the efficiency of his instruction will be decreased.

The advantages of the second system of securing a practical experience, where the professor leaves the teaching field, takes up outside work, and then returns to teaching, are that during his practical career he will be very much alive to the points he should look into, and, furthermore, if he returns to teaching he will possess the advantage of having experience both as a teacher and as a practical engineer. We all know that there is much more to the right sort of teaching than a thorough knowledge of the subject to be taught, and that the old saying 'a man must be born a teacher' contains much truth. It is, indeed, just as necessary that a successful teacher shall have the right qualities as an instructor, as that he shall possess the necessary knowledge. The main disadvantage of the second method is that if a professor makes a success in the practical field his financial reward may, as already stated, be so great that it will be hard to tempt him back to teaching.

We will now take up the third method, where a professor obtains his practical experience by conducting outside work in connection with his college duties. In the first place, let us consider the subject from

the standpoint of the man himself. If he is an enthusiast, this method of obtaining an experience will lead to harder work on his part than either of the others. This assumes that his college work is not neglected, and that by doing the outside work he is making his course at all times better and more useful to the students. In this connection something may be said about the methods of teaching in engineering schools. I believe that the one proper way to teach an engineering subject is for the professor at the head of a department to get down to hard work with his students, and to know each of them so well that he is thoroughly acquainted with their personal characteristics. Certain parts of his course can be turned over to assistants, but the moment he avails himself of the assistance of others to such an extent that he is no longer in close relationship with the students, his efficiency in instruction will be decreased. In other words, the professor must exert himself to the utmost to secure the best results with his students, and when this is done, there is no harder way to gain a practical experience than by the undertaking of outside work, and if the professor is an enthusiast there is often much danger of his breaking down under the strain. On the other hand, if he manages to secure an experience which will give him the reputation of being an authority in his field, he usually will make the best sort of a teacher, and be a credit to the college with which he is connected. All this assumes that the classes are not too large, and I am a thorough believer in comparatively small classes, and also that his teaching roster is so arranged that he will have time available for the outside work. It would certainly be unfair to expect a professor to gain a reputation in either research or commercial work if his time is so fully occupied with class work that, with the exception of his summer vacation, there would be little time

except the evenings in which to do such work. One must not be misled, however, in thinking that if some definite time, say a certain number of days each week, is set aside for the purpose that this will make it an easy matter for a professor to undertake practical work. If he is an enthusiast he will find that he must often stand up to his task night after night, and unless he is willing to do this it is folly for him to undertake to gain an experience in the way indicated.

From the standpoint of the college, allowing the professors to undertake any and every sort of work to gain a practical experience is a most dangerous one. There is a tendency in many cases to do work for which the professor has not the proper capacity, and in this way he may throw discredit on his college. There is nothing that will so greatly damage the reputation of a professor, and in turn of the college with which he is connected, as the issuance of a report which shows him to be incapable of properly coping with the subject, or which is in the nature of an advertisement for this or that machine or commodity. The outside work undertaken by a professor should be that of a scientific or strictly engineering type. In much of the work his reports simply recite facts deduced from various test data, whereas in others it is necessary for him to render an opinion. There is danger in arriving at false deductions as well as in advancing false opinions, and unless the professor can be thoroughly trusted, it would be better to cut out all such work. There is also a great danger of a professor bringing disrepute to his college if he is careless in his testimony as an expert. If his testimony in this line is wilfully misleading, or if he depart a hairsbreadth from truth, it were well that he had never been given the chance of lowering the dignity of his profession. On the other hand, a strictly

honest and able man may bring credit to his college by his success and acknowledged fairness in this same line of work.

The advantage to a college in having its professors do research and outside work is that what reflects to the credit of the professor will reflect to the credit of the college. Furthermore, the college will be looked to as a source from which an unbiased opinion can be obtained, and in maintaining this standard it will be fulfilling a high and useful mission. The results of the investigations may be made the subjects of scientific papers to be read before the various societies, and any reputation that a professor gains in this way will benefit his college. Furthermore, the college gains through the acquisition of much of the apparatus used in the investigations. The college will also be the gainer financially, because if a professor is allowed to do professional work what he receives from this source really pays a part of his salary. Aside from a financial gain in this way, however, it is a question whether a college should endeavor to secure any great financial return from such work. There should be enough earned directly by the college to pay for the use of the apparatus, the wear and tear, etc., and for providing a fund for the purchase of new apparatus for the work; but aside from this, it is my opinion that the college need not be the financial gainer. I say this because if too much stress is laid on the money-getting side of the problem, it will not be possible to do the right sort of work, and to do it in a proper way. A party may be willing to pay a large sum for an investigation of a project where it is evident that no matter what results are obtained they will not add to the scientific knowledge of those undertaking the work, and where it is also evident that all that is wanted is the name of the professor, and that of the college with which he is connected, for promoting the

project. Such work should never be undertaken, no matter what the commercial returns may be. On the other hand, a poor inventor may desire to have a test made on some machine which he has constructed, and in which there appears to be a possibility of development, and such a test might well be undertaken although it may give no financial return. The proper sort of commercial work to do in connection with a college is that of a research character, or where scientific results are obtained. It will be found that when the work is limited to this sort that it often cuts off much that is of a less desirable nature, but in which the financial returns would be greater.

In all that has been said so far it is assumed that it is necessary for certain professors to have an experience in the outside field. I do not think any one will question this. One is apt to get into a rut in teaching and to have his mental horizon narrowed so that he can not perceive his own faults, and there is no better way of expanding this horizon than to be a co-worker with practical men. The main advantage that a practical teacher has over one who is purely theoretical is that he can make his course interesting by the introduction of practical examples, and in this way incite the students to study intelligently, which is the real measure of his success. He may, however, make the mistake of introducing too many practical details into the course. It is essential above all that the fundamentals of the subject shall be mastered, and the true use of practical problems, aside from securing the interest of the class, is to show that their solution is based on a few broad underlying principles. A practical man may also make a mistake in thinking that his way of looking at a problem is so simple and straightforward that it will surely be grasped by the students. In teaching, however, he will find that after

presenting a subject in what he considers a way that all must understand, there will be many, possibly the majority of the class, that have failed to grasp his reasoning. Men's minds work differently, and the path taken to arrive at the understanding of a problem will vary, so that unless a subject is presented in several ways the explanation given by a professor may fail to fall into the line of thought of many of his students, and he will be disappointed in the results obtained.

It is a fact, however, that there are many professors who have had little or no outside experience. This often occurs where a young man enters the profession of teaching directly after his graduation, and is placed in such a position that it is impossible for him to undertake any practical work. Such a professor may make the best sort of a tutor, and may be most successful in imparting the fundamentals of a subject, but when it comes to being put in charge of a practical engineering department, it is here that his lack of experience will be very much felt. In a certain sense it is unfair for a head professor to secure the services of a recent graduate and keep him continually at teaching so as not to allow him to gain outside experience. Much thought has been put on this phase of the problem. Mr. Walter C. Kerr, in connection with his work as a trustee of Cornell University, has been in favor of the plan that a professor be thrown upon his own resources and be compelled to work in the practical field one year out of seven. This might appear all right from a business standpoint of the college involved, but how about older professors who have worked long in the teaching line, and have not had the necessary outside experience to qualify them for taking a position in the practical field? It might be very inconvenient for such a professor to have to accept a nominal salary in order to gain experience, but this

certainly would follow if he had been so loaded down with teaching that he was given no opportunity to work at the practical side of his profession. On the other hand, if a professor through hard work and diligence has obtained experience in the outside field, while he is a teacher, and is forced, at the end of seven years, to enter the practical field, it is very probable that his success therein may be such that he could not be tempted back to teaching.

From the foundation of the Stevens Institute to the present time, the professors have been encouraged to do practical work. At all times this work has been done on their own responsibility, that is the institute was not responsible for any of the reports given out. On the other hand, it has been well appreciated that should erroneous or undignified reports be made it would reflect discredit on the institute, and great care has been taken that this should not occur. In 1894 the late Dr. Morton, who as you all know was the first president of the institute, established what he called the department of tests, the aims of which he described as follows:

It is part of the institute's policy to make its laboratories and workshops the center of such experimental investigations as will be of direct commercial importance to the mechanical engineering profession, and likewise contribute to the same valuable technical information by which the knowledge of facts and principles which constitute the foundation of that profession may be enlarged. It is also part of the same policy to have its professors so in touch with the most advanced practise as to enable them to embody, in their courses of instruction, the best results of applied science in engineering practise.

A department of tests has, therefore, been organized to undertake measurements of the performance of steam-engines and other motors, and of the efficiency of boilers, refrigerating machines and mechanisms generally, including electrical and hydraulic apparatus, also to make tests of strength of materials, and to make various chemical and physical investigations, for the general public. Such work is assigned by the president to the member of the faculty best fitted to suc-

cessfully undertake any particular investigation, and the extensive facilities of the institute in the way of working space, apparatus, workshop appliances, skilled observers and mechanics are placed at the latter's disposal.

This might make it appear that all testing work from that time on was to be done by the institute as an institution, but such was not the case. No other than personal reports have been issued by the professors who have undertaken the work, and in every case the professors themselves have been entirely responsible for the payment of all expenses connected with the tests. In many cases the expenses of tests are quite large, and the payment of these must be secured either by obtaining a retainer or deposit from the parties for whom the work is to be done, or the professor making the test must run the risk of having to pay these expenses himself should the parties for whom he is doing the work fail to meet their obligations. This looking after the financial end of the problem is an essential one, as it gives the professors experience on the commercial as well as the engineering side of the work.

It has been claimed that the professors of an engineering college should not do work in the practical field, as this interferes with the consulting engineers who depend for their livelihood on just the sort of work that would be apt to be undertaken at a college. This is a very narrow view to take of the matter, and as far as my own personal experience is concerned, I can testify to the fact that much of the work undertaken in connection with my college duties has been done for consulting experts. The day is past when there can be a strict line drawn between the work of the consulting engineer and that of the professor who teaches in the same field. The ideal professor in a given line should be able to take up the work of the consulting engineer in that line, and the ideal consulting engineer should possess enough technical knowl-

edge to fit him for being a professor. There should be no jealousy, but rather a bond of friendship in that the fundamentals which each should master are the same.

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*ADDRESS BEFORE THE CENTRAL
BOTANISTS.¹*

THE opening of the year 1902 was marked by the assembling in Chicago of the American Society of Naturalists, an association based on strict professional requirements for membership, which for reasons of expediency had limited its meetings to the eastern part of the country—a limitation specially set aside for the purpose of holding this Chicago meeting. With the Society of Naturalists had become affiliated a considerable number of equally strong professional organizations devoted to branches of nature study. All were largely indebted for their existence to the need that every student and teacher feels of the stimulus of personal contact with his peers in the work to which he is devoting his life.

The great summer gatherings of the American Association for the Advancement of Science, with its greater variety of interests and less strictly limited membership, had seemed not to give opportunity for this contact in the way desired, and the general and special bodies of naturalists, a large part of whom were also members of the association, had provided for meetings such as they desired in the short college recess of the Christmas season. Into this recess, lengthened for the purpose by a considerable number of colleges, the American Association had deliberately moved its own meeting, in the hope that the active workers of the entire country, in every field of science, might find it possible to meet together as a single great body, impos-

¹ Presidential address at the Ann Arbor meeting, December 28, 1905.